

# **ONR Subsequent Mine Burial Experiments FY03 Final Report**

Sean Griffin

Omni Technologies, Inc.

7412 Lakeshore Drive

New Orleans, LA 70124

phone: (504) 288-8211 fax: (504) 288-2899 email: [sgriffin@otiengineering.com](mailto:sgriffin@otiengineering.com)

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## **LONG-TERM GOALS**

Our long-term goal is to characterize the subsequent mine burial process by developing the techniques and the instruments necessary to measure the process.

## **OBJECTIVES**

Our objectives are to first measure the mine burial process under various environmental factors and secondly to measure the near field processes that effect burial. The first objective is accomplished by developing the techniques (measurement and signal processing) to obtain mine orientation (roll, pitch and azimuth), acceleration (3-axes) and percent burial in-situ. The second objective is to be accomplished by developing the techniques to simultaneously obtain near field pressure variations, flow, scour pit development, suspended sediment size and concentration, and temperature.

## **APPROACH**

Our approach has been to develop cylindrically shaped mines instrumented with the capability to measure the following properties:

- 1) Roll, Pitch and Azimuth
- 2) +/-4 G's on all 3 mine axes
- 3) 112 Acoustic Burial Transducers
- 4) 6 pressure transducers
- 5) 6 Doppler Flow Sensors
- 6) Temperature Sensors
- 7) Near field backscatter of suspended sediments at 750 kHz, 1.5 MHz and 3.0 MHz

## **WORK COMPLETED**

OTI has completed the fabrication of four (2 under ONR funding) instrumented mines in December of 2002 (Fig. 1).

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***Figure 1 – Subsequent Burial Instrumented Mines Ready for Indian Rocks Experiment***

All four mines were successfully deployed and recovered in the winter and spring of 2003 off the cost of Tampa Bay, FL at Indian Rocks (Fig. 2).



***Figure 2 – Partially Buried Instrumented Mine in Fine Sands. Scour developing on ends.***

Data was obtained for all four mines over the entire Indian Rocks experiment. OTI preprocessed much of this data and provided this data to others who requested the data. OTI has been working on processing techniques and improvements since retrieval of the mines in April 2003.

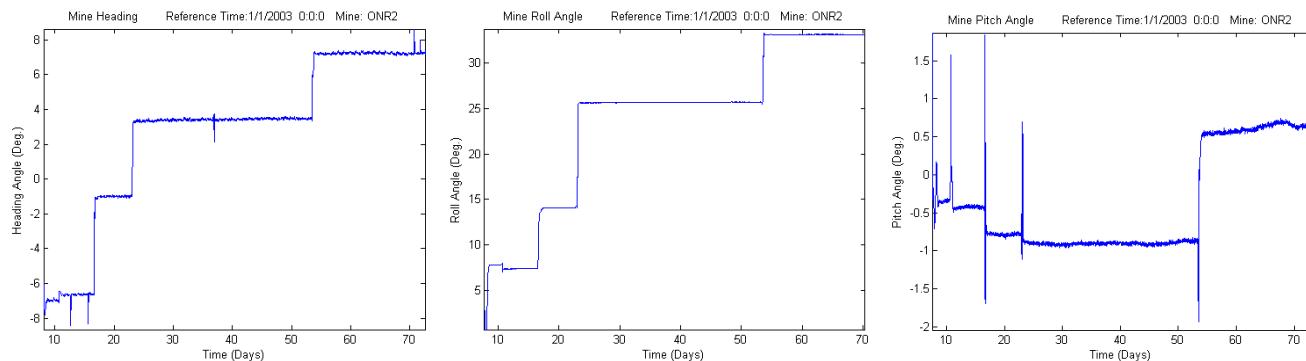
The pressure, temperature and orientation data was excellent and software tools are in development to process and display the large data sets. The burial data is still inconclusive since the backscatter at the transducer faces was less than anticipated and the acoustic energy at the interface time gate (due to ringdown and urethane/water impedance mismatch) is larger than we would like. OTI has made some modifications to the burial system and has found that the burial calculation is significantly more distinguishable at 750 kHz as opposed to 1.5 MHz. OTI has replaced poor or failed burial transducers (150 total on all 4 mines) for the Martha Vineyard Experiment.

OTI has yet to work on suspended sediment backscatter and flow processing.

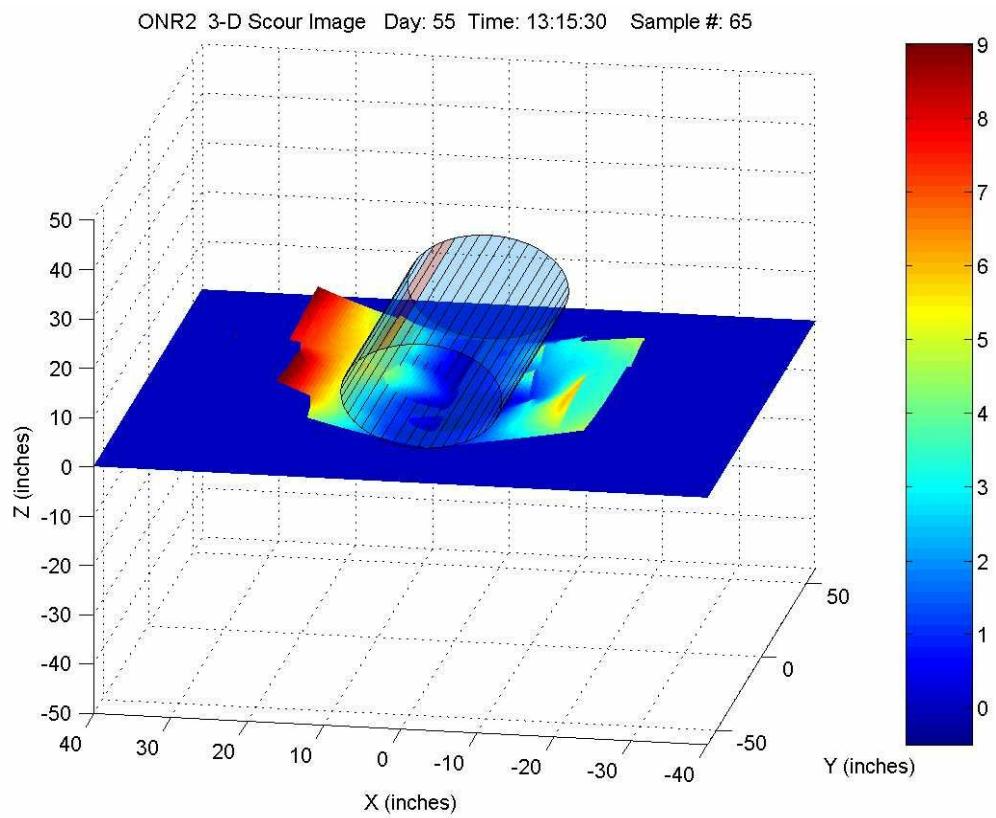
OTI has spent much of the summer working on preparing the mines to be redeployed for the Martha Vineyard's Experiment this fall. All were shipped to Martha's Vineyard the last week in September 2003.

## RESULTS

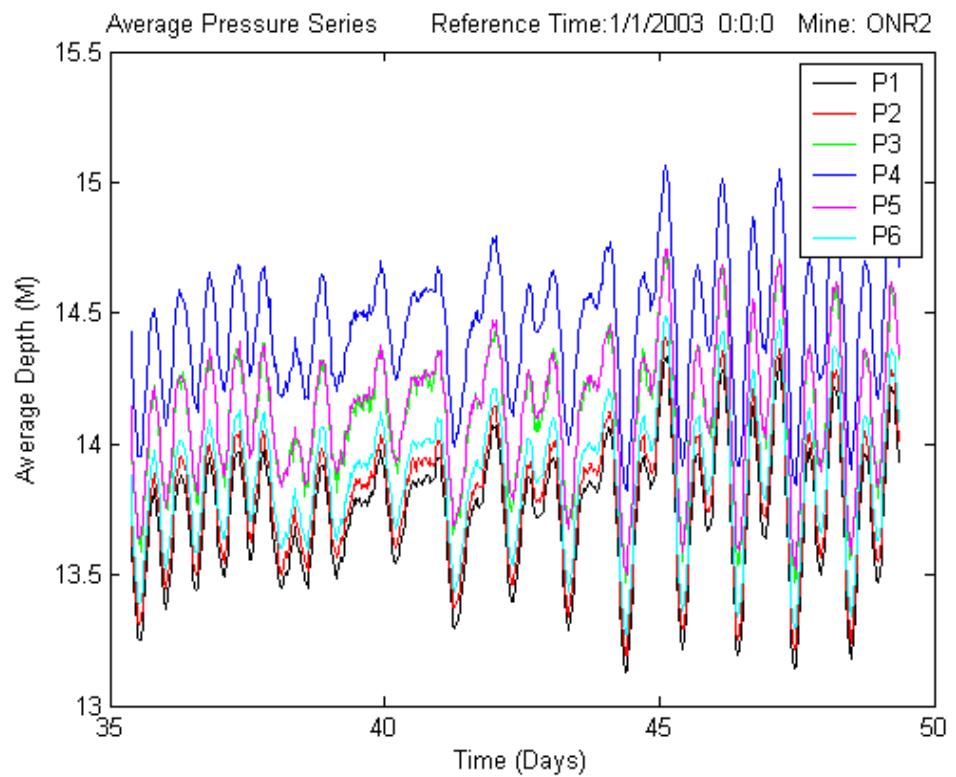
OTI has obtained data from all four instrumented mines. All four mines recorded movement after deployment. This movement is related to the direction of travel of surface gravity waves (Fig. 3). In addition, scour pit development was also measured using the burial transducer as demonstrated in Figure 4. Pressure measurements providing estimates of tidal movement and significant wave heights were also obtained and have been processed (Figure 5). Techniques are still being developed to process the burial, backscatter and flow measurements.



**Figure 3 - Recorded Motion of an Instrumented Mine at Indian Rocks**



**Figure 4 – 3D Scour Measurement from Indian Rocks**



**Figure 5 – Average Pressure from Indian Rocks**

## IMPACT/APPLICATIONS

The future impact is that the burial data obtained from this work will be required to validate burial models that are being developed. Diver observations are too imprecise and not often enough to (under sampled) provide validation for the burial process.

## TRANSITIONS

The Instrumented Mines are by nature transition products. Omni Technologies, Inc. is marketing the units to fleet resources as exercise mines.

## RELATED PROJECTS

All projects related to the ONR Mine Burial program.

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